METHOD FOR MANUFACTURING AND GOLF CLUB HEAD

Background of the Invention

Field of the Invention

The present invention relates to an improved method for producing a golf club head, and more particularly to an improved method of producing a club head made of a carbon fiber composite.

Description of the Related Art

A wood-type golf club typically includes a hollow shaft with a club head attached to the lower end of the shaft. The club head typically includes a load-bearing outer shell with an integral or attached strike plate. The strike plate defines a substantially planar front surface or strike face for striking a golf ball.

A recent trend in the industry is to make the club head out of strong, yet lightweight material, such as, for example, titanium, a titanium alloy or a carbon fiber composite. Of these materials, carbon fiber composites are particularly interesting to golf club designers because it has a density that is roughly one third of the density of titanium but is almost as strong as titanium. Accordingly, carbon fiber composites are particularly suitable for very large club heads (i.e., club heads that define an internal volume greater than 400 centimeters cubed).

Despite their low density and strength, club heads that are made entirely of carbon fiber composites are generally not popular. This is due, in part, to the relatively high stiffness that is typical of carbon fiber composites. Such stiffness usually is undesirable especially in the strike plate. Moreover, carbon fiber composites are not particularly durable. Thus, composite club heads have a tendency to wear out in the areas that are subjected large amounts of wear and friction (e.g., the sole of the club head).

To overcome some of these problems, it has been suggested that the club head be made from a combination of titanium or alloy and carbon fiber composites. Specifically, it has been suggested that a club head can be formed from an outer shell made of a carbon fiber composite, which is attached to a strike plate made of a titanium or a titanium alloy. However, existing methods for manufacturing such a club have not been satisfactory. For

example, one golf club manufacturer attempted to co-cure a metal strike plate with a composite outer shell. More specifically, a metal strike plate was placed in a mold along with an inflatable bladder that was surrounded by a uncured composite material. To cure the composite, the bladder was inflated to press the uncured material against the mold and the strike plate. However, fitting the strike face into mold and removing the bladder from the cured club head was difficult and time consuming.

Summary of the Invention

An aspect of the present invention is an improved method for producing a club head comprising of a metal strike plate and a composite shell. A further aspect of the present invention is the realization that such a club can be produced by attaching the metal strike plate to the composite shell after the composite shell is formed. However, for the metal strike plate to be successfully attached to the strike plate the composite shell must be produced in a manner that ensures tight tolerances and smooth surfaces on both the inside surfaces and outside surfaces of the shell.

Accordingly, one aspect of the invention is a method for forming a golf club head. The method comprises placing an uncured composite material between a core and a mold that comprises a first piece and a second piece. The second piece is moved towards the first piece such that the uncured composite material is compressed between the core and at least a portion of the mold. The uncured composite material is heated. A first portion of the golf club head is removed from the mold. A second portion of the golf club head is provided. The first portion is attached to the second portion.

Another aspect of the invention is a method for forming a golf club head. The method comprises placing an uncured composite material between a core and a mold that comprises a first piece and a second piece. The second piece is moved towards the first piece such that the uncured composite material is compressed between the core and at least a portion of the mold. The uncured composite material is heated. A first mating section is formed on the first portion. A first portion of the golf club head is removed from the mold. A second portion of the golf club head is provided. The first portion is attached to the second portion.

Yet another aspect of the invention is a golf club head comprising a shell made of a composite material that is attached to a strike plate that is formed of a metallic

material. The shell includes a first mating section and the strike plate including a second mating section configured to mate with the first mating section.

Still yet another aspect of the present invention is a golf club head comprising a shell made of a composite material that is attached to a strike/sole plate combination. The strike/sole plate combination includes strike plate and sole plate, which are integrally formed and made of a metallic material. The shell includes a first mating section and the strike/sole plate combination includes a second mating section configured to mate with the first mating section.

For purposes of summarizing the invention and the advantages achieved over the prior art, certain objects and advantages of the invention have been described herein above. Of course, it is to be understood that not necessarily all such objects or advantages may be achieved in accordance with any particular embodiment of the invention. Thus, for example, those skilled in the art will recognize that the invention may be embodied or carried out in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other objects or advantages as may be taught or suggested herein.

All of these embodiments are intended to be within the scope of the invention herein disclosed. These and other embodiments of the present invention will become readily apparent to those skilled in the art from the following detailed description of the preferred embodiments having reference to the attached figures, the invention not being limited to any particular preferred embodiment(s) disclosed.

Brief Description of the Drawings

These and other features of the invention will now be described with reference to the drawings of a preferred embodiment, which are intended to illustrate and not to limit the invention, and in which:

Figure 1 is a front perspective view of a golf club head having certain features and advantages according to the present invention;

Figure 2 is a rear perspective of the golf club head of Figure 1;

Figure 3A is a cross-sectional view of the golf club head of Figure 1;

Figure 3B is an enlarged cross-sectional view of the area with the circle labeled 3B of Figure 3A;

Figure 3C is a cross-sectional view of a modified arrangement of a golf club head;

Figure 4 is a side perspective view of a strike/sole plate combination and outer shell of the club head of Figure 1;

Figure 5 is a top view of the strike/sole plate combination of Figure 4;

Figure 6 is a cross-sectional view of a mold according to a method in the prior art;

Figure 7 is cross-sectional view of a mold according to another method in the prior art;

Figure 8 is a perspective view of a mold for a golf club head having certain features and advantages according to the present invention ;

Figure 9A is a front view of a core of the mold of Figure 8;

Figure 9B is a right side view of the core;

Figure 9C is a left side view of the core;

Figure 9D is a top view of the core;

Figure 9E is a bottom view of the core;

Figure 10 is a cross-sectional view of the mold of Figure 8;

Figure 11A is a top view of a first mold piece of the mold of Figure 8;

Figure 11B is a front view of the first mold piece;

Figure 12A is front view of a second mold piece of the mold of Figure 8; and

Figure 12B is a bottom view of the second mold piece.

Detailed Description of the Preferred Embodiment

Figures 1-5 illustrated a club head 10 having certain features and advantages according to the present invention. With initial reference to Figure 1, the club head 10 comprises a strike plate 12. The strike plate 12 defines a substantially planar front surface or strike face 14 for impacting a golf ball. A hosel 16 extends upward from the strike plate 12. The hosel 16 is configured to be coupled to a golf club shaft (not shown) in a well known manner. The strike plate 12 is preferably made of a strong, yet lightweight metal, such as, for example, titanium or a titanium alloy.

The club head 10 also comprises an outer shell 20 that is preferably made of a strong yet lightweight composite material, such as, for example, a carbon fiber reinforced

epoxy or carbon fiber reinforced polymer. As best seen in Figure 3A, the outer shell 20 includes an inner surface 21, which defines an interior volume 22 of the club head 10, and an outer surface 23. The club head 10 also includes a toe region 24 and a heel region 26, as is well known. The bottom of the club head 10 is delimited in part by a sole 28 and the top of the club head is delimited by a crown 30.

With particular reference to Figures 2 and 4, the illustrated club head 10 also comprises a sole plate 32, which extends along the center of the sole 28 from the strike plate 12 to the rear of the club head 10. As best seen in Figure 4, in the illustrated arrangement, the sole plate 32 is formed integrally with the strike plate 12. That is, the sole plate 32 and the strike plate 12 form a single strike/sole plate combination 34. The outer shell 20 preferably is attached to this sole/strike plate combination 34, as will be described in more detail below. The sole plate 32 protects the 28 sole of the club head 10 from friction and wear during a golf swing. Accordingly, the sole plate 32 preferably is made of a material that is more durable than the shell 20, such as, for example, a metal. More preferably, the sole plate 32 is made of the same strong, yet lightweight metal as the strike plate 12. It should be appreciated, however, that several features and advantages of the present invention can be achieved in an arrangement wherein the strike plate 12 and the sole plate 32 are not integrally formed (i.e., the strike plate 12 and the sole plate 32 are separate pieces). Moreover, in some arrangements of the present invention, the club head 10 can be formed without the sole plate 32. In other arrangements, the club head 10 can be formed without the strike plate 12. However, the illustrated arrangement is preferred because the mechanical properties of metal are particularly suited for the strike plate 12 and the sole plate 32. As mentioned above, the strike plate 12 and the sole plate 32 are preferably made of a strong, yet light weight metal, such as, for example, titanium. In such an arrangement, the strike plate 12 and/or the sole plate 32 can be formed by casting, forging, rolling or a combination of casting, forging and/or rolling.

Figure 3C illustrates another arrangement of the club head 10. In this arrangement, the club head 10 includes an inner shell 35 that is preferably integrally formed with the strike/sole plate combination 34. In this arrangement, the inner shell 35 defines the inner surface 21 of the club head 35. The inner shell 35 is preferably made of the same strong, yet lightweight metal as the strike/sole plate combination. The outer

surface 23 of the club head 10 is defined by the outer shell 20, which surrounds the inner shell 35 and is preferably made of a strong yet lightweight composite material, such as, for example, a carbon fiber reinforced epoxy or carbon fiber reinforced polymer.

As mentioned above, the outer shell 20 preferably is attached to the strike/sole plate combination 34. To improve the strength of the connection between the outer shell 20 and the strike/sole plate combination 34, the outer shell 20 and the strike/sole plate combination 34 preferably include an interlocking joint 36, which is best seen in Figures 3A and 3B. In the illustrated embodiment, the joint 36 comprises mating sections 38a, 38b formed on the outer shell 20 and the strike/sole plate combination 34 respectively. Each mating section 38a, 38b preferably includes an abutment surface 39a, 39b that is transverse to the outer surface 23. More preferably, the abutment surface 39a, 39b, lies substantially normal to the outer surface 23. The abutment 39a, 39b surfaces help to align the shell 20 with the strike/sole plate combination 34 and to prevent lateral movement of these two components 20, 24 with respect to each other. Each mating section 38a, 38b, preferably also includes an attachment surface 41a, 41b. The attachment surfaces 41a, 41b are at least two (2) times, and preferably, four (4) times as wide as the thickness t of the outer shell 20. The attachment surfaces 41a, 41b preferably provide a surface for an adhesive as will be explained in more detail below. The attachment surfaces 41a, 41b preferably are generally parallel to the outer surface 23 of the shell 20 and midway between the inner surface 21 and outer surface 23 of the outer shell 20. This arrangement is preferred because it permits a longer attachment surface and thicker mating sections 38a, 38b, which increases the strength of the joint 36 and the bond between the shell 20 and the strike/sole plate combination 34 respectively. In the arrangement illustrated in Figure 3C, the attachment surfaces 41a, 41b can extend along the entire length of the outer shell 20.

As best seen in Figure 4, the mating sections 38a, 38b, preferably extend completely along the interface between the outer shell 20 and the strike/sole plate 34 combination. However, it should be appreciated that, in a modified arrangement, the mating sections 38a, 38b could extend only partially along the interface between the outer shell 20 and the strike/sole plate combination 34. In the illustrated arrangement, each piece 38a, 38b includes two abutment surfaces 39a, 39b, which are separated by

the attachment surfaces 41a, 41b. That is, the abutment surfaces 39a, 39b, and the attachment surfaces 41a, 41b, form an interlocking steps. However, it should be appreciated that the mating sections 38a, 38b can be formed into a variety of other shapes giving due consideration to the preference of providing a secure connection between the outer shell 20 and the strike/sole plate combination 34. For example, the mating sections 38a, 38b can comprise an interlocking tongue and groove arrangement or a matching inclined surface arrangement, each of which includes abutment surfaces 39a, 39b and attachment surfaces 41a, 41b.

To permanently secure the outer shell 20 to the strike/sole plate combination 34, an adhesive, such as, for example, an epoxy is applied to one or both of the mating sections 38a, 38b, preferably, along the attachment surfaces 41a, 41b. In a modified arrangement, the outer shell 20 can be secured to the strike/sole plate combination 34 by fasteners that can extend through the joint 36. As best seen in Figure 3A and 5, the sole plate 32 preferably includes an annular rib 40, which extends from the periphery of the sole plate 32 and into the cavity 22 of the club head 10. The annular rib 40 advantageously increases the rigidity of the sole plate 32. Of course, those of skill in the art will recognize that the sole plate 32 can be formed without the annular rib 40.

To ensure a secure bond between the outer shell 20 and the strike/sole plate combination 34, the joint 36 (i.e., the interlocking step surfaces 38a, 38b) preferably are made with tight tolerances and smooth surfaces. More preferably, these components are made with a tolerance that is less than approximately ± 0.15 millimeters . With respect to the interlocking step surface 38a of the outer shell 20, prior methods for producing carbon fiber club heads are not adequate for creating the desired tight tolerances and smooth surfaces. This is especially true with respect to the inner surface 21 of the outer shell 20 and the portion of which forms the interlocking step surface 38a of the outer shell 20 (see Figure 3B).

For example, Figure 6 shows a cross-section of a carbon fiber club head being produced according to the methods of the prior art. According to this technique, an uncured composite material 50 is wrapped around an inflatable bladder 52. The bladder 52 and the composite material 50 are placed within a mold 54 and heated to a specified temperature to soften the uncured composite. The bladder 52 then is inflated with

pressurized air, steam or oil through one or more openings 56. As the bladder 52 expands, the composite material 50 is pressed against the inner surfaces 55 of the mold 54. After the composite material 50 cures, the golf club head is removed from the mold 54 and the bladder 52 is deflated and removed from the golf club through the one or more openings 56.

One problem with the above-described method is that it is difficult to obtain tight tolerances and smooth surfaces on the interior surfaces 58 of the club head. This difficulty is due primarily to the nature of the inflatable bladder 52. As the bladder 52 expands, the composite material 50 is pressed against the hard smooth inner surface 55 of the mold 54. This tends to produce a smooth surface on the outer surfaces 60 of the composite material. In contrast, the relatively flexible surface of the inflatable bladder 52 presses against the interior surfaces 58 of the composite material. This tends to produce an uneven surface, which makes it difficult to obtain the tight tolerances and smooth surfaces.

A technique that is likely to be more successful in obtaining tight tolerance on the interior surfaces of the club head is shown in Figure 7. This method uses, sheets 60 of fibrous material that are wrapped around a core 62 made of a low melting point alloy. The core 62 and the fibrous material 60 are placed within a cavity of a splittable mold 64 made of a pair of mold halves 66, 68. The fibrous material 60 lies within a peripheral gap is formed between the core 62 and the mold 68. Once the core 62 and fibrous material 60 are in place, resin is injected into the peripheral gap through an opening 70. The resin flows through the fibrous material and hardens to form the golf club head. The mold 68 is heated to melt the core 62, which can be removed from a hole 72 formed in the club head.

This method, however, has a number of significant drawbacks. For example, because the resin must flow through the fibrous material, the fiber loading of the fibrous material must be kept to a relatively small amount. This reduces the strength of the final composite material. The method also requires the two halves 66, 68 of the mold 64 to be sealed so as to prevent the resin from leaking out of the mold 64. This increases the cost of manufacturing.

To address the above-noted problems, Applicant has invented a method for manufacturing a golf club having certain features and advantages. The method utilizes a mold 98, which is shown in Figure 8. The mold includes a core or mandrel 100, which is shown in detail in Figure 9A-E. The core preferably is made of a hard material, such as, for example, aluminum or steel. Preferably, the core 100 comprises a first piece 102a and a second piece 102b. However, it should be appreciated that the core 100 can comprise a single piece or more than two pieces. The two piece construction is preferred for reasons that will be set forth below. The core 100 defines an exterior surface 104, which corresponds generally to the desired shape of the interior surface 21 of the outer shell 20. In particular, the exterior surface 104 includes a ridge 106 that forms an analog to the interlocking step surface 38a of the club head 10 (see Figure 4). Of course, if the joint 36 has a different configuration the exterior surface 104 can be modified accordingly.

The mold 98 also comprises a first mold piece 112, which is shown in Figures 8 and 10-11B. The first mold piece 112 includes an inner surface 114, which generally corresponds to the desired shape of a portion of the outer shell's 20 exterior surface 23. More specifically, in the illustrated arrangement, the inner surface 114 of the mold corresponds to a lower portion (i.e., the portion of outer shell 20 that lies generally below the crown 30) of shell's 20 exterior surface 23. The illustrated first mold piece 112 also includes a spacing groove 116. The groove 116 is configured to receive a tongue piece 118 that is formed on the core 100 (see Figures 9A, 9B, and 10). The tongue 118 and groove 116 cooperate to properly align the core 100 within the cavity 110. While the tongue 118 and groove 116 are preferred for the simplicity and reliability, those skilled in the art will recognize that there are other ways to ensure the proper alignment of the core 100 within the cavity 110.

The mold 98 further includes a second mold piece 120, which is shown in Figures 8, 10, 13 and 14. The second mold piece 120 has a second inner surface 122, which preferably is configured to generally correspond to the desired shape of the crown 30. The top portion 120 is further configured such that it can be moved towards or away from the first mold piece 112. Accordingly, as shown in Figure 8 , the top portion 112 is connected to the bottom portion 110 by a plurality of shafts 124, which are

threaded. The shafts 124 preferably extend through threaded holes formed in the second mold piece 122 and threaded holes formed in the first mold piece 112. Thus, the second mold piece 120 can be moved towards the first mold piece 112 by rotating the shafts 120. Of course, those skilled in the art will recognize that there are other ways for moving the first and second mold pieces 112, 122 towards each other.

As shown in Figure 8 and 10, the mold 98 preferably also includes a third mold piece 130. The third mold piece 130 includes a third inner surface 132, which is configured to contact a portion 134 of the exterior surface 104 of the core 100.

To form the outer shell 20 of the club head 10, an uncured composite material 150 is placed (i.e., laying up) around the core 100 (see Figure 10). The uncured composite material 150 preferably is a carbon fiber reinforced thermoset resin or a carbon fiber reinforced plastic resin. The composite material 150 and the core 100 preferably are then placed within the first mold piece 112. Once the core 100 is in place, the third mold piece 130 is attached, preferably with bolts (not shown), to the first mold piece 112. In this position, the third mold piece 130 securely holds the core 100 and composite material 150 within the first mold piece 112.

The second mold piece 130 then is moved towards the first mold piece 112. Accordingly, the uncured composite material 150 is compressed between the first, second mold pieces 112, 120 and the core 100. As the second mold piece 120 is moved towards the first mold piece 112, the lower surface 152 (see Figure 10) of the second mold piece 120 eventually contacts the upper surface 154 of the first mold piece 112, resulting in a positive stop. Preferably, the first and second mold pieces 112, 120 are configured such that when the lower and uppers surfaces 152, 154 contact a uniform gap exists between the second piece 120 and the core 100. In this manner, the composite material 150 is uniformly compressed between the first and second mold pieces 112, 120 and the core 100.

Preferably, while the composite material 150 is being compressed, the mold 98 is being heated in an oven to a temperature between 200-500 degrees Fahrenheit. More preferably, the mold 98 is heated to a temperature of approximately 350 degree Fahrenheit for approximately 10 minutes. The compressing and heating cures the

composite material 150 into the desired shape, which is determined by the shape of the core 100 and the inner surfaces 114, 122 of the first and second mold pieces 112, 120.

After the composite material 150 is cured, the second and third mold pieces are removed. The core 100 can then be removed form the cured shell 20. The illustrated two piece construction of the core 100 aides the removal of the core 100. The finished shell 200 is removed from the mold 98 and attached to a corresponding strike/sole plate 34 combination with epoxy as described above.

In the illustrated arrangement, the strike/sole plate combination 34 is made of titanium or a titanium alloy. This arrangement is preferred because the material properties of titanium are particularly suited for the strike plate 12 and the sole plate 32. However, it should be appreciated that, in a modified arrangement, the above-described method can also be utilized for a club head wherein the strike plate 12 and/or the sole plate 32 are made of a composite material. In such an arrangement, a second mold (not shown) can be formed utilizing the principles described above. The second mold can be used to create a strike plate, a sole plate, or a strike/sole plate combination made of a composite material.

In another modified arrangement, the core 100 is attached to or integrally formed with the first mold piece 112. In such an arrangement, the uncured composite material 150 is placed over the core 100. The second mold piece 130 then is moved towards the first mold piece 112. After the composite material cures, the composite material 150 can be removed from the first mold piece 112.

Although this invention has been disclosed in the context of certain preferred embodiments and examples, it will be understood by those skilled in the art that the present invention extends beyond the specifically disclosed embodiments to other alternative embodiments and/or uses of the invention and obvious modifications and equivalents thereof. In addition, while a number of variations of the invention have been shown and described in detail, other modifications, which are within the scope of this invention, will be readily apparent to those of skill in the art based upon this disclosure. It is also contemplated that various combination or subcombinations of the specific features and aspects of the embodiments may be made and still fall within the scope of the invention. Accordingly, it should be understood that various features and aspects of the

disclosed embodiments can be combine with or substituted for one another in order to form varying modes of the disclosed invention. Thus, it is intended that the scope of the present invention herein disclosed should not be limited by the particular disclosed embodiments described above, but should be determined only by a fair reading of the claims that follow.